

2015 Quality Assurance Report Atmospheric Mercury Network



National Atmospheric Deposition Program

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Abbreviations

AMNet	Atmospheric Mercury Network
GEM	Gaseous Elemental Mercury (expressed in ng/m ³)
GOM	Gaseous Oxidized Mercury (expressed in pg/m ³)
MDN	Mercury Deposition Network
NADP	National Atmospheric Deposition Program
PBM _{2.5}	Particulate-Bound Mercury less than 2.5 μm in diameter (expressed in pg/m ³)
QAP	Quality Assurance Program
SOP	Standard Operating Procedures

Units and Conversion Factors

°F	degrees Fahrenheit
°C	degrees Celsius
cm	centimeters
L	liters
μl	microliter (1 μl = 10 ⁻⁶ L)
lpm	liters per minute
ng	nanograms (1 ng = 10 ⁻⁹ g)
ng/m ³	nanograms per cubic meter
pg	picograms (1 pg = 10 ⁻¹² g)
pg/m ³	picograms per cubic meter

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1.0 Introduction

The Atmospheric Mercury Network (AMNet) started in 2009. In 2015 the network consisted of 21 sites across North America and one site (Mt LuLin) in Taiwan (Table 1). The concentration of gaseous elemental mercury (GEM) was measured at all sites. Speciated mercury: gaseous oxidized mercury (GOM), and particulate bound mercury (PBM_{2.5}), was measured at 20 sites in 2015. All measurements followed the AMNet Standard Operating Procedures (SOPs). The AMNet Site Liaison provides remote technical support to site operators in the operation of AMNet equipment, performs site performance and systems surveys, and reviews the data on a monthly basis to identify problems. Data review includes both manual and automated quality control checks. Site operators are notified whenever problems are discovered.

In 2015 sixteen sites were surveyed by the AMNet Site Liaison. This report includes a summary of the findings from each of the surveys.

Table 1. AMNet Sites

NADP Site ID	State	Operating Agency	START_DATE	END_DATE	Lapse
AK03	Alaska	National Park Service	2/5/2014	Current	
AL19	Alabama	ARA Inc.	1/1/2009	Current	
CA48	California	UC Santa Cruz	1/1/2010	12/31/2011	
FL96	Florida	ARA Inc.	1/1/2009	Current	
GA40	Georgia	ARA Inc.	1/1/2009	Current	
HI00	Hawaii	NOAA/EPA	12/30/2010	Current	
MD08	Maryland	University of Maryland	1/1/2008	Current	6/30/2011 - 1/12/2012
MD99	Maryland	NOAA	1/26/2007	7/17/2014	
MD98	Maryland	NOAA	11/7/2006	Current	
ME97	Maine	Micmac Tribe	12/3/2013	Current	
MI09	Michigan	University of Michigan	8/10/2015	Current	
MS12	Mississippi	NOAA	9/29/2006	Current	
MS99	Mississippi	NOAA	10/18/2007	11/12/2012	
NH06	New Hampshire	University of New Hampshire	1/1/2009	11/29/2011	
NJ05	New Jersey	State of New Jersey	6/1/2009	4/30/2010	
NS01	Nova Scotia, Canada	Environment Canada	1/26/2009	Current	
NU15	Nunavut, Canada	Environment Canada	1/4/2002	Current	
NY06	New York	State of New York	8/27/2008	Current	
NY20	New York	SUNY ESF	11/21/2007	Current	
NY43	New York	State of New York	11/21/2007	Current	
OH02	Ohio	Ohio University	1/1/2007	Current	2/15/2012 – 9/24/2013
OH52	Ohio	Ohio State University	1/1/2012	Current	
OK99	Oklahoma	Cherokee Nation	10/20/2008	Current	
PA13	Pennsylvania	NOAA	4/1/2011	11/10/2011	
UT96	Utah	University of Utah	6/18/2009	6/30/2011	
UT97	Utah	State of Utah	11/23/2008	Current	
VT99	Vermont	University of Vermont	1/1/2008	Current	
WI07	Wisconsin	State of Wisconsin	2/1/2012	Current	
WV99	West Virginia	NOAA	1/1/2007	10/14/2012	
TW01	Taiwan	EPA Taiwan	1/1/2010	Current	

Changes in 2015 include the following:

MI09 (Douglas Lake) initiated GEM, GOM and PBM_{2.5} analysis on August 10, 2015

Changes to data in 2015 include the following:

Throughout 2015, instrumentation at AL19 (Birmingham), GA40 (Yorkville) and FL96 (Pensacola) was configured at 25°C, whereas AMNet protocol is 0°C. Results for the entire year were multiplied by 1.087 standardizing the data to match AMNet protocol.

2.0 Site Performance and Systems Surveys

Sites are surveyed at least once every two years by the AMNet Site Liaison. Normally, the site performance and systems surveys would be performed by an independent entity. This is true for the other four NADP networks. The expertise required to operate and troubleshoot the AMNet instrumentation inhibits an independent third party from providing this service. Field survey reports are completed to document problems that are discovered and their resolution.

Site surveys evaluate both field and laboratory operations (including equipment operation), and siting criteria. Site surveys ensure data comparability within the network, resolve operational problems that may not be apparent in data review, and address training needs at each site.

Additional information regarding site surveys may be found in the document titled *Atmospheric Mercury Network: Site Performance and Systems Survey*. This document is available from the NADP website (<http://nadp.isws.illinois.edu/>).

2.1 AMNet Sites Surveyed in 2015

Site surveys were conducted at sixteen AMNet sites in 2015. Station ID's, survey dates and station names are presented in Table 2.

Table 2. AMNet Sites Surveyed in 2015.

Site ID	Station Name	Survey Date
AK03	Denali	11/12/2015
AL19	Birmingham	5/20/2015
FL96	Pensacola	7/29/2015
GA40	Yorkville	5/18/2015
MD99	Beltsville	3/9/2015
MI09	Pellston	8/10/2015
MS12	Grand Bay NERR	7/27/2015
NS01	Kejimkujik	10/6/2015
01NS	Kejimkujik new site	10/7/2015
NS29	Dartmouth	10/8/2015
NY06	Bronx	3/25/2015
NY43	Rochester	3/23/2015
OK99	Stilwell	2/3/2015
TW01	Mount LuLin	12/16/2015
UT97	Salt Lake City	2/20/2015
WI07	Horicon	11/17/2015

2.2 Instrument Test Results

As part of the site survey, instrument sensitivity (i.e., response factor) and the internal calibration source are verified. Independent, third party calibration certificates for the survey test equipment are included in the appendix to this document.

Table 3 lists the serial numbers for the AMNet instruments at each site. Illegible serial numbers are listed as “n/a” (not available). Not present instruments are listed as “n/p”. AK03 (Denali) measures GEM only.

Table 3. Serial Numbers for Instruments at Surveyed Sites.

Site ID	1102	2537	1130P	1130	1135	2505
AK03	n/p	51	n/p	n/p	n/p	n/p
AL19	73	320	87	9	n/a	144
FL96	74	86	9	n/a	n/a	28
GA40	n/a	93	55	n/a	4	28
MD99	5	KT4XF	118	n/a	n/a	104
MI09	n/p	345	95	91	81	n/p
MS12	36	291	69	66	53	147
NS01	89	189	143	146	124	90
01NS	127	34	137	n/a	89	90
NS29	115	39	n/a	n/a	n/a	90
NY06	89	5035	84	n/a	n/a	n/p
NY43	46	5039	147	144	133	n/p
OK99	56	335	90	86	76	n/p
TW01	n/p	210	63	n/a	n/a	100
UT97	77	364	105	103	88	169
WI07	95	396	117	n/a	n/a	231

Table 4 lists the results [i.e., pass (p), fail (f)] for each test of the field instruments. Criteria for assigning pass/fail are defined in *Atmospheric Mercury Network: Site Performance and Systems Survey*. Significant deviation from the test criteria are indicated with an uppercase F. Parameters that were not tested are listed as “n/a.”

Table 4. Survey Results.

Site ID	Survey Date	Air Flow and Leak Tests				Cartridge A and B Recoveries			
		Temps OK	Inlet Flow	2537 Flow	Leak Check	Response Factor	Low Level	High Level	Ambient Air
AK03	11/12/2015	p	n/a	p	p	p	p	p	p
AL19	5/20/2015	p	n/a	p	p	p	p	p	p
FL96	7/29/2015	p	n/a	p	p	p	p	p	n/a
GA40	5/18/2015	p	p	p	p	p	p	f	f
MD99	3/9/2015	p	p	p	n/a	p	p	p	p
MI09	8/10/2015	p	p	p	n/a	p	n/a	n/a	n/a
MS12	7/27/2015	p	p	p	p	p	p	p	p
NS01	10/6/2015	p	p	p	p	p	p	P	p
01NS	10/7/2015	p	p	p	p	p	p	p	p
NS29	10/8/2015	p	p	p	p	p	p	p	p
NY06	3/25/2015	p	p	p	p	p	p	p	p
NY43	3/23/2015	p	p	p	p	p	p	p	p
OK99	2/3/2015	p	p	p	n/a	p	p	p	f
TW01	12/16/2015	p	n/a	n/a	p	p	p	p	p
UT97	2/20/2015	p	p	n/a	p	p	p	p	f
WI07	11/17/2015	p	p	p	p	p	p	p	p

2.3 Siting Criteria

Compliance with siting criteria is evaluated with regard to obstructions (>20°) in each of 8 directions (i.e., N, NE, E, SE, S, SW, W, and NW) from the instrument inlet. Also, the height from the ground to each inlet is measured. Results are presented in Table 5. Obstructions are evaluated as pass (p)/fail (f). Deviations from the siting criteria are discussed with the operator during the site survey. Corrective action, when possible, is the responsibility of the site operator and the site supervisor. Site photos can be found at <http://nadp.isws.illinois.edu/data/sites/list/?net=AMNet>

Table 5. Siting Criteria Obstructions and Inlet Heights.

Site	Inlet Height (m)	N	NE	E	SE	S	SW	W	NW
AK03	3.2	p	p	p	p	p	p	p	p
AL19	5.2	p	p	p	p	p	p	p	p
FL96	5.2	p	p	p	p	p	p	p	p
GA40	5.2	p	p	p	p	p	p	p	p
MD99	10.0	p	p	p	p	p	p	p	p
MI09	1.4	p	p	p	p	p	p	p	p
MS12	10.0	p	p	p	p	p	p	p	p
NS01	4.7	p	p	p	p	p	p	p	p
01NS	7.0	p	p	p	p	p	p	p	p
NS29	20.0	p	p	p	p	p	p	p	p
NY06	9.1	f	f	p	p	f	p	p	f
NY43	5.4	f	p	p	p	p	p	p	f
OK99	4.8	p	p	p	p	p	p	p	p
TW01	6.5	p	p	p	p	p	p	p	p
UT97	8.2	p	p	p	p	p	p	p	p
WI07	4.8	p	p	p	p	p	p	p	p

2.4 Instrument Repairs

In 2015, instruments at five sites (AK03, AL19, NY06, OK99 and UT97) required repairs in order to complete the survey. The same number of instruments required repair in 2014.

2.5 Test Equipment Calibration

Two Bios Definer 220 flow meters are used to verify analyzer and inlet flow rates. The high range meter (3-30 lpm) is used to measure the inlet flow rate. The medium range meter (0.5-5 lpm) is used to measure the 2537 sample flow rate. Each meter is certified annually by the manufacturer. Certification includes checking the thermocouple, the barometer and three flow

rates across the range of the instrument. Values are reported both pre- and post-calibration (i.e., as-received and as-shipped). Table 6 lists the calibration results for the two flow meters as reported in January 2015 (the start of the reporting year) and in January 2016 (the end of the reporting year).

Table 6. Flow Meter Calibration Results for 2015 and 2016.

Flow Meter		Calibration Date	
		01/2015	01/2016
medium range (0.5 – 5.0 lpm)	as-received	Thermocoupler 1.4°C low (tolerance $\pm 0.8^\circ\text{C}$)	within tolerance for all parameters
	as-shipped	within tolerance for all parameters	within tolerance for all parameters
high range (3 – 30 lpm)	as-received	flow rates 4% high (tolerance $\pm 1\%$) temperature within tolerance	within tolerance for all parameters
	as-shipped	within tolerance for all parameters	within tolerance for all parameters

Throughout 2015, prior to site visits, field flow meters were verified against the laboratory flow meters. Both meters were checked 6 times and the greatest difference was 1.2% on the high range meter on 03/21/2015. All other checks were well below 1% difference.

A Tekran 2505 Mercury Vapor Primary Calibration Unit and a certified Hamilton 25 uL syringe (model 1702RN) are used to validate instrument internal permeation sources. On April 16, 2014 and on January 18, 2016 the syringe was found to be within tolerance both as-received and as-shipped. The syringe was not certified in 2015, but will be certified on an annual basis moving forward.

3.0 Training

There were no official AMNet training sessions held in 2015. Operator performance is reviewed with each site visit.

4.0 Data

AMNet data are evaluated using a series of automated checks and through manual inspection by the AMNet Site Liaison. Additional information on this process is available in the *Atmospheric Mercury Network Data Management Manual*. Table 7 lists the percentage of valid data collected at each site in 2015. Values are presented for each of the three forms of mercury that are measured including: GEM, GOM, and PBM_{2.5}. Three sites did not meet data quality objectives ($\geq 75\%$ data completeness on annual basis) for GEM in 2015. Four sites did not meet data quality objectives for GOM, and 4 sites for PBM_{2.5}.

AL19 – Gold cartridge bias was a common problem early and late in 2015, both in calibrations and ambient air concentrations.

HI00 – Much of the data was excluded because experiments were being performed which may have affected the concentrations.

MS12 – Exterior sampling heads experienced extended periods of down time due to power failures.

NY06 – The PBM_{2.5} heater was down for several periods early in 2015.

OK99 – Data completeness improved from 2014 to 2015, but was still below the criterion for completeness. Data were not submitted for a significant portion of the year.

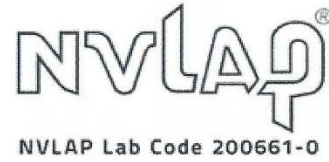
UT97 – Much of the data was invalidated due to trap bias.

Table 7. Percent Valid Data by Site for 2015.

Site ID	GEM	GOM	PBM_{2.5}
AK03	85	n/a	n/a
AL19	64	95	95
FL96	99	95	95
GA40	85	84	84
HI00	65	65	67
MD08	90	96	96
MD98	96	95	96
ME97	n/a	n/a	n/a
MI09*	70	94	94
MS12	93	73	75
NS01	98	95	95
NU15	Data QA performed external to NADP.		
NY06	97	93	70
NY20	97	89	89
NY43	96	95	95
OH02	93	94	80
OH52	84	81	81
OK99	79	71	72
UT97	44	64	65
VT99	97	93	93
WI07	93	93	91
TW01	Data QA performed external to NADP.		
Average	85	85	83

* partial year. MI09 started on 8/10/2015.

Appendix – Test Equipment Calibration Documents



Calibration Certificate

CertificateNo. 69306	Sold To: National Atmospheric Deposition Program (NADP) 2204 Griffith Drive Champaign, IL 61820 US
Product 200-220H Definer 220 High Flow	
Serial No. 114711	
Cal. Date 12-Jan-2016	

All calibrations are performed at Mesa Laboratories, Inc., 10 Park Place, Butler, NJ, 07405, an ISO 17025:2005 accredited laboratory through NVLAP of NIST. This report shall not be reproduced except in full without the written approval of the laboratory. Results only relate to the items calibrated. This report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

As Received Calibration Data

Technician	Lilianna Malinowska	Lab. Pressure	749 mmHg
		Lab. Temperature	22.5 °C

Instrument Reading	Lab Standard Reading	Deviation	Allowable Deviation	As Received
25293 sccm	25107 sccm	0.74%	1.00%	In Tolerance
5031.1 sccm	5001.2 sccm	0.6%	1.00%	In Tolerance
1508.7 sccm	1501.45 sccm	0.48%	1.00%	In tolerance
21.5 °C	22.2 °C	-	± 0.8°C	In Tolerance
750 mmHg	749 mmHg	-	± 3.5 mmHg	In Tolerance

Mesa Laboratories Standards Used

Description	Standard Serial Number	Calibration Date	Calibration Due Date
ML-800-44	103521	23-Jun-2015	22-Jun-2016
Precision Thermometer	305460	21-Sep-2015	20-Sep-2016
Precision Barometer	2981392	28-Jun-2015	27-Jun-2016



As Shipped Calibration Data

Certificate No	69306	Lab. Pressure	751 mmHg
Technician	Lilianna Malinowska	Lab. Temperature	22.5 °C

Instrument Reading	Lab Standard Reading	Deviation	Allowable Deviation	As Shipped
25341 sccm	25242.5sccm	0.39%	1.00%	In Tolerance
5025.9 sccm	5000.3 sccm	0.51%	1.00%	In Tolerance
1507.5 sccm	1500.45 sccm	0.47%	1.00%	In Tolerance
22.5 °C	22.5 °C	-	± 0.8°C	In Tolerance
751 mmHg	751 mmHg	-	± 3.5 mmHg	In Tolerance

Mesa Laboratories Standards Used

Description	Standard Serial Number	Calibration Date	Calibration Due Date
ML-800-44	101897	29-Nov-2015	28-Nov-2016
Precision Thermometer	305460	21-Sep-2015	20-Sep-2016
Precision Barometer	2981392	28-Jun-2015	27-Jun-2016

Calibration Notes

The expanded uncertainty of flow, temperature, and pressure measurements all have a coverage factor of $k = 2$ for a confidence interval of approximately 95%.

Flow testing is in accordance with our test number PR18-13 with an expanded uncertainty of 0.18% using high-purity nitrogen or filtered laboratory air. Flow readings in sccm are performed at STP of 21.1°C and 760 mmHg.

Pressure testing is in accordance with our test number PR18-11 with an expanded uncertainty of 0.16 mmHg.

Temperature testing is in accordance with our test number PR18-12 with an expanded uncertainty of 0.04 °C.

Traceability to the International System of Units (SI) is verified by accreditation to ISO/IEC 17025 by NVLAP under NVLAP Code 200661-0.

Technician Notes:

Louis Guido, Chief Metrologist



Calibration Certificate

CertificateNo. 69305	Sold To: National Atmospheric Deposition Program (NADP) 2204 Griffith Drive Champaign, IL 61820 US
Product 200-220M Definer 220 Medium Flow	
Serial No. 113878	
Cal. Date 11-Jan-2016	

All calibrations are performed at Mesa Laboratories, Inc., 10 Park Place, Butler, NJ, 07405, an ISO 17025:2005 accredited laboratory through NVLAP of NIST. This report shall not be reproduced except in full without the written approval of the laboratory. Results only relate to the items calibrated. This report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

As Received Calibration Data

Technician	Lilianna Malinowska	Lab. Pressure	748 mmHg
		Lab. Temperature	22.6 °C

Instrument Reading	Lab Standard Reading	Deviation	Allowable Deviation	As Received
4510.1 sccm	4500.8 sccm	0.21%	1.00%	In Tolerance
1003.5 sccm	1000.55 sccm	0.29%	1.00%	In Tolerance
247.93 sccm	250.29 sccm	-0.94%	1.00%	In tolerance
20.7 °C	22.3 °C	-	± 0.8°C	In Tolerance
748 mmHg	748 mmHg	-	± 3.5 mmHg	In Tolerance

Mesa Laboratories Standards Used

Description	Standard Serial Number	Calibration Date	Calibration Due Date
ML-800-24	100439	03-Jun-2015	02-Jun-2016
Precision Thermometer	305460	21-Sep-2015	20-Sep-2016
Precision Barometer	2981392	28-Jun-2015	27-Jun-2016

©Ogee X411146

CERTIFICATE of CALIBRATION

This is to Certify that

the following described Hamilton Digital Syringe has been calibrated by Hamilton Company, and is accurate within $\pm 0.5\%$ of full scale reading.

This Digital Syringe, as specified below, has been calibrated as a complete assembly at ambient pressure. The calibration is performed pursuant to ANSI/NCSL Z540-1-1994, with an unbroken chain of calibrations traceable to NIST.

Capacity 25 μ l
Model 1702RN,25UL
Serial No. 06793

HAMILTON
THE MEASURE OF EXCELLENCESM

4970 Energy Way • Reno, Nevada • 89502-4178 • U.S.A.
Telephone +1-775-858-3000 • Fax +1-775-858-7259
Toll Free 800-648-5950

Date of Calibration April 16, 2014

Calibrated by Klaus Frome

ISO 9001
CERTIFIED

P/N69042 (Rev. G)

NIST test numbers: 822/272872-11 (Mass) W208715 (Temp) 821/276375-08 (Length)

LTHQ IN USA

© Gees X411146

CERTIFICATE of CALIBRATION

This is to Certify that

the following described Hamilton Digital Syringe has been calibrated by Hamilton Company, and is accurate within $\pm 0.5\%$ of full scale reading.

This Digital Syringe, as specified below, has been calibrated as a complete assembly at ambient pressure. The calibration is performed pursuant to ANSI/NCCL Z540-1-1994, with an unbroken chain of calibrations traceable to NIST.

Capacity 25 μ l

Model 1702RN,25UL

Serial No. 06793 Accuracy 0.094%

Date of Calibration January 18, 2016

Calibrated by Klaus Horn

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Telephone +1-775-858-3000 • Fax +1-775-856-7259
Toll Free 800-648-5950

ISO 9001
CERTIFIED

P/N69042 (Rev. G)

NIST test numbers: 822/272872-11 (Mass) Y227751 (Temp) 621/986457-14 (Length)

LITHO IN U.S.A.